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IMPROVED ENERGY PRODUCTION ESTIMATES BY ACCOUNTING FOR THE WIND SHEAR

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Introduction

An estimation of the Annual Energy Production (AEP) is the basis for any wind energy project. The AEP estimate is obtained by combining the wind speed distribution measured at a proposed site with a wind turbine power curve, measured at the manufacturer's test site. Even if the wind speed is measured at (and below) hub height during the site assessment, the wind speed shear can significantly affect the AEP estimation, since the wind energy available actually depends on the kinetic energy contained in the whole wind speed profile. Given the large variation in speed profiles from one site to another and from one season to another, the kinetic energy estimated from the hub height wind speed is rarely truly representative of the total kinetic energy impinging the wind turbine.

Approach

Main body of abstract

An equivalent wind speed concept has previously been introduced where the kinetic energy impinging the entire rotor disc is represented as a single, equivalent wind speed (ueq). The use of this equivalent wind speed has been shown to improve the power curve measurements as it accounts for the variations of wind shear over the entire rotor disc. Clearly, this equivalent wind speed is a better representation of the available energy than the wind speed at hub height (uhub) when there is wind shear. This method is now proposed in the revision of the IEC 61400-12-1, especially since wind speed profiles can now easily be measured over the whole rotor span of even large wind turbines by using lidars or sodars. Probably, in the foreseeable future, two power curves will be available for each wind turbine type: one traditional with the wind speed at hub height and one, independent of the shear, with the equivalent wind speed.

The novelty presented in this paper is the use the equivalent wind speed also in the site assessment. It is shown that the combination of the power curve obtained with ueq with the distribution of ueq measured at the assessed site results in a better AEP estimate than the conventional method based on uhub. This is because the AEP estimate using ueq accounts both for the shear occurring during the power curve measurement and the shear at the assessed site. However, quantifying the distribution of ueq requires measuring the whole wind speed profile during the site assessment.

Conclusion

In the case where the speed profile has not been measured at the proposed site, it is shown that using a combination of the ueq power curve and the distribution of uhub results in errors in the AEP that depend on the respective shear at the proposed site and the power curve site. Without detailed knowledge of the shear at both sites, such a strategy can not be recommended. With knowledge of the shear, an AEP estimate based on ueq is always preferable.